Abies grandis

Grand Fir

Grand fir (*Abies grandis*) is found in three different parts of Washington. The largest area is the two-fifths of the state that lies between the east slope of the Cascades and the Pacific Ocean with the exception of the Olympic Mountains. The other two areas are the Okanogan Highlands (in the northeast corner of the state) and the Blue Mountains (in the southeast corner). The latter two areas are connected to some extent by extensive grand fir populations in northern Idaho (Little 1971).

Grand fir occupies different types of sites in these areas. In parts of Vancouver Island and coastal British Columbia that adjoin Washington, it grows from sea level to 1000 feet, where it may receive more than 100 inches of annual precipitation. In western Washington it grows in moist valleys and stream bottoms. Elevations there range from 600 to 1000 feet with 30 to 45 inches of annual precipitation. As you move south through the range along the west side of the Cascades, the elevational range of the species increases. On the east slope of the Washington Cascades, grand fir is found below 4000 feet in elevation. Although range maps show a continuous distribution across the Cascades, there is very little grand fir above 3000 feet on the west side of these mountains in Washington. In the Blue Mountains and parts of Idaho, it is usually found between 2000 and 5000 feet, although it occurs as high as 6000 feet. There it receives between 14 and 39 inches of annual precipitation (Foiles *et al*. 1990). In some places, grand fir has extended its range east of the area indicated by Little in 1971. Although the map of seed transfer zones is based on Little's range map, the written descriptions accommodate these changes.

Some authors mention a green coastal form and a grey interior form of grand fir. With spatially separated populations that occupy very different types of sites, it is somewhat surprising that no taxonomic varieties have been recognized for this species (Foiles *et al*. 1990). Grand fir is thought to hybridize with white fir in the southern and central Oregon Cascades and in the Blue Mountains. Grand fir-like trees in these areas tend to grow more slowly than other grand fir.

No studies have been conducted specifically to determine rules for seed transfer in grand fir. A number of studies have been designed to determine the best sources of grand fir for planting in certain areas. None of these have been conducted in Washington, but studies conducted in Europe, British Columbia, and Idaho have included sources of grand fir from this state. These tests can be used to infer differences among its populations in traits like growth potential, cold hardiness, and time of bud set and bud burst. Populations that are known to differ in adaptively important traits should usually be kept separate from each other.

Many researchers working in relatively mild climates have reported that sources from the Puget Sound area and the southern end of Vancouver Island have the greatest growth potential (Scholz and Stephen 1982; König 1995; Kleinschmit *et al*. 1996; Xie and Yang 1996). Several researchers have reported that populations from the east side of the Cascades have less growth potential than populations from somewhat lower elevations on the west side of the

Cascades (Scholz and Stephen 1982, König 1995, and Xie and Yang 1996). Xie and Ying (1993) reported that higher elevation sources tend to grow more slowly than lower elevation sources. Kleinschmit *et al*. (1996) reported that differences in growth potential were not associated with differences in elevation along a transect across Oregon, but their samples included material from the east and west sides of the Coast Range and the Cascades, which may have masked elevation trends. When a subset of their samples that progressed from the floor of the Willamette Valley to Santiam Pass was examined, there was an obvious trend of decreased growth potential with increasing elevation. Many researchers have reported that sources from further north appear to have a greater growth potential (Steinhoff 1984, Xie and Ying 1993, Kleinschmidt *et al*. 1996, and Magnesen 1996), but this trend does not appear to be related to significant changes in adaptively important gradients within the state of Washington. It may be an artifact of the sampling scheme (*i.e.* northern sources were often collected at lower elevations) or it could be due to introgression from the slower growing white fir in the central Oregon Cascades (Zobel 1973).

Greater growth potential does not always mean greater growth. It can be associated with susceptibility to early fall frosts or late spring frosts in relatively cold climates. Sources from coastal areas tended to be more susceptible to frost than sources from other areas (Steinhoff 1984), sources from lower elevations tended to be more susceptible than sources from higher elevations (Magnesen 1996), and sources from the Rocky Mountains had more frost injury than sources from the Cascades (Scholz and Stephen 1982, and Steinhoff 1984). Artificial freezing tests can be used to evaluate cold hardiness without waiting for fortuitous frosts. Larson (1978) found that coastal sources were less cold hardy in the fall and in the spring than Cascade sources, and that cold hardiness of southern sources tended to be lower than the cold hardiness of northern sources, both in the Cascades and along the coast. Larsen and Ruetz (1980) also found that cold hardiness tended to increase with increasing elevation and distance from the Pacific Ocean.

Xie and Ying (1993) reported that sources from the east side of the Cascades tend to have more foliar disease when planted in the moister west side and that coastal sources tended to have less disease than any of the other sources. Kleinschmidt *et al*. (1996) reported that the amount of lammas growth varied with the latitude, longitude, and elevation of the seed source.

New recommendations for seed transfer zone boundaries

HOH (Zone 1): The coastal areas near the west side of the Olympic Mountains. Consists of the portions of the old 011 and 012 seed zones within the natural distribution of grand fir.

TWIN HARBORS (Zone 2): The coastal areas south of the Olympic Mountains. Consists of the old 030 seed zone and those parts of the old 041 seed zone west of Skamokawa.

PUGET SOUND (Zone 3): Areas around Puget Sound and in the rain shadow of the Olympic Mountains and Vancouver Island. Consists primarily of the old 201, 202, 211, 212, 221, 222, and 231 seed zones as well as the western parts of the old 411 and 412 seed zones. The southern border is a line from near Capitol Peak in the Olympic Mountains southeast toward South Mountain, east to Bay Shore, Lakebay, Tacoma, east to Highway 167 then south to Sumner, Highway 410 to Buckley, and east to the Three Sisters at the 4000-foot contour.

UPPER CHEHALIS (Zone 4): Areas south of the Puget Sound between the coastal zone and the west slope of the Cascades. Consists primarily of the old 232, 241, and 242 seed zones as well as the eastern part of the old 041 seed zone and western parts of the old 421, 422, 430, and 042 seed zones.

SKAGIT (Zone 5): West side of the Cascades north of Interstate 90 (Snoqualmie Pass). Consists primarily of the old 401, 402, and 403 seed zones as well as the eastern portion of the old 411 seed zone and the northeastern part of the old 412 seed zone.

COWLITZ (Zone 6): West side of the Cascades south of Interstate 90 (Snoqualmie Pass). Consists of the old 440 seed zone as well as the eastern parts of the old 421, 422, 430 and 042 seed zones and the southeastern part of the old 412 seed zone.

CHELAN (Zone 7): East side of the Cascades north of Interstate 90 (Snoqualmie Pass). Consists primarily of the portions of the old 600, 621, and 622 seed zones where grand fir occurs, as well as the northwestern portion of the old 631 seed zone.

KLICKITAT (Zone 8): East side of the Cascades south of Interstate 90 (Snoqualmie Pass). Consists primarily of the portions of the old 641, 651, 652, and 653 seed zones where grand fir occurs.

UPPER COLUMBIA (Zone 9): Northeast corner of the state. Consists primarily of the old 614, 801, 802, 811, 812 , 821 and 822 seed zones as well as parts of zones 612, 803 and 813.

GRANDE RONDE (Zone 10): Southeast corner of the state and nearby parts of Oregon and Idaho. Consists primarily of those parts of the old 861 and 851 Washington seed zones within the range of grand fir and the old 861 Oregon seed zone.

Elevation bands within geographic seed transfer zones

Within each seed movement zone, 1000-foot elevation bands should be established.